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OVIPOSITION PREFERENCE OF THE BLACK-HEADED BUDWORM AND HOST PHENOLOGY

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INTRODUCTION

The history of the black-headed budworm, *Acleris variana* (Fern.), in the western hemlock-Sitka spruce forests of coastal Alaska is one of recurring outbreaks. Extensive top-killing and whole-tree mortality results from repeated defoliation.

The budworm readily attacks both western hemlock, *Tsuga heterophylla* (Raf.) Sarg., and Sitka spruce, *Picea sitchensis* (Bong.) Carr., and laboratory studies show that rate of insect development is similar on both species.[1] Field surveys and observations have shown that pure stands of Sitka spruce are not as severely defoliated as adjacent stands of hemlock. Reasons for greater damage to hemlock were not known, but a possible oviposition preference and an apparent difference in phenology of the two tree species were suspected. These factors were, therefore, studied to clarify the budworm-host tree relationship.

A brief review of the life history of the black-headed budworm will show how host-tree phenology may be important to the early establishment of larvae. Black-headed budworm eggs are laid singly on current-year foliage during September. The eggs remain on the foliage over winter and hatch the following June. On western hemlock the newly hatched larvae immediately migrate to buds and bore into them. Spruce shoots begin to elongate before budworm eggs hatch, so buds are not available to the young larvae. The larvae leave the expanding hemlock buds some time after completing the first molt, but usually before the third instar is reached. Needles are clipped and webbed into a loose shelter where the larvae complete development and pupate. In about two weeks moths emerge, mate, and lay eggs.

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[1] Unpublished data on file at the Northern Forest Experiment Station.

METHODS

Field work was done in 1964 and 1965 at Limestone Inlet, about 22 miles south of Juneau, Alaska.

Eight potted Sitka spruce seedlings were paired with eight potted western hemlock seedlings of similar size. The seedlings were placed outdoors in screen cages, one pair per cage, so that the trees were equally exposed to sunlight and precipitation.

Four male and four female black-headed budworm moths that had been reared as larvae on Sitka spruce were placed in each of four randomly assigned cages. The remaining cages each received four male and four female moths that had been reared as larvae on western hemlock. An additional four females and one male that had been reared on western hemlock were placed in each of the latter four cages one week later. No additional spruce-reared budworms were available.

Seasonal shoot elongation was measured weekly on Sitka spruce and western hemlock. Ten trees of each species were selected on both north and south aspects. Two terminal shoots of primary branches about 5 feet above ground were tagged and measured on each of the 40 trees. Measurements were made and recorded to the nearest millimeter, using the base of the bud as a reference point. Measurements were started before the buds broke dormancy and continued until after growth stopped. All insects were removed from the shoots.

The trees used for phenological measurements also provided the budworms needed for studies of development. Ten or more insects were collected from the mid-crown of each tree once each week. Head capsule measurements were used to determine larval instar.

RESULTS

Oviposition preference

Table 1 shows that western hemlock was the preferred host for egg laying by spruce-reared as well as hemlock-reared budworms. This preference occurred despite the existence of more oviposition sites on spruce, since hemlock had fewer linear inches of new foliage and fewer needles per inch of foliage than did the spruce.

Host phenology

Figure 1A shows the relationship between western hemlock growth and budworm development. The beginning of bud expansion and egg hatch occur at the same time. The slowly expanding bud provides food and shelter for the budworm larvae.

The relationship between Sitka spruce growth and budworm development is shown in figure 1B. At the peak of egg hatch, the spruce shoots have completed about 50 percent of their growth. Since early instar larvae are incapable of clipping needles to form shelters, they are exposed to weather and predators.

Shoot growth of both tree species was greater and started earlier on the south aspect. Budworm development on the south aspect was also faster. Shoot growth was more affected by aspect than was budworm development, however. The average shoot length of both species was greater on the south aspect at the peak of all budworm stages.

CONCLUSION

Budworms prefer hemlock foliage for egg laying, which probably accounts for the more severe defoliation of hemlock than adjacent spruce. During prolonged outbreaks, when hemlock is severely defoliated, budworms may be forced to lay eggs on spruce. It is likely that fewer of these budworm larvae survive than those on hemlock because the rapidly expanding spruce shoots do not provide the shelter found in hemlock buds.

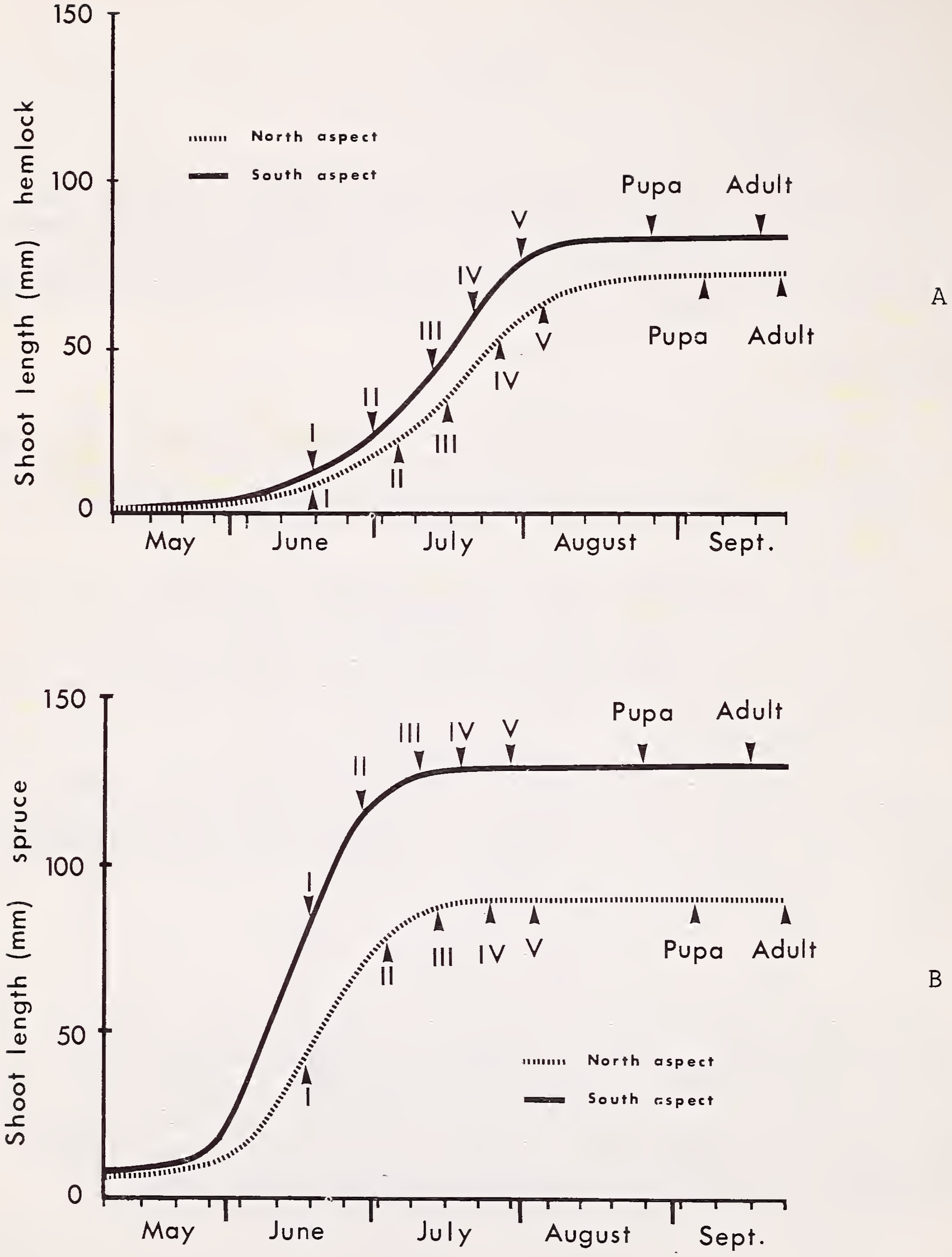

Figure 1.--The relationship of black-headed budworm development to shoot growth of A, western hemlock, and B, Sitka spruce. Numerals represent larval instars. Arrows indicate time of peak occurrence of each stage.

Table 1.--Oviposition preference by the black-headed budworm

Cage number	Moths reared on:	Eggs laid on:	
		Western hemlock	Sitka spruce
		Number	Number
1	western hemlock	26	3
4	" "	83	4
6	" "	32	7
7	" "	132	17
2	Sitka spruce	24	3
3	" "	3	2
5	" "	16	1
8	" "	3	0
Totals[1]		319	37

[1] The ratio of eggs laid on western hemlock to eggs laid on Sitka spruce by spruce-reared moths is 7.7 to 1; by hemlock-reared moths, 8.8 to 1; and combined, 8.6 to 1.

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